EPIDEMIOLOGY, MICROBIOLOGY AND VISUAL OUTCOME OF MICROBIAL KERATITIS IN MADURAI

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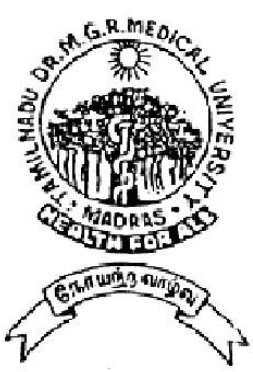

THE TAMILNADU

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CERTIFICATE

Certified that this **Dissertation on EPIDEMIOLOGY, MICROBIOLOGY AND VISUAL OUTCOME OF MICROBIAL KERATITIS IN MADURAI"** is the bonafide record of work done by **Dr D. ANANDHI**, Post Graduate Student in M.S. ophthalmology, Madurai Medical College, Madurai, submitted in partial fulfillment of the requirement for the M.S. (Branch III) Ophthalmology Examination of **the Tamilnadu Dr. M.G.R. Medical University**, March 2008.

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DECLARATION

I, **Dr. D. ANANDHI** solemnly declare that the dissertation titled **"EPIDEMIOLOGY, MICROBIOLOGY AND VISUAL OUTCOME OF MICROBIAL KERATITIS IN MADURAI"** has been prepared by me.

This is submitted to The Tamil Nadu Dr. M.G.R. Medical University, Chennai, in partial fulfillment of the requirement for the award of M.S.,(Ophthalmology) Branch - III degree Examination to be held in MARCH 2008.

Place : Madurai

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INTRODUCTION

The World Health Organization has recognized corneal blindness resulting from microbial keratitis as a major cause of visual disability (1). The incidence of corneal ulcers was 113 per 1 lakh population in 1993, 10 times that of the US. A good understanding of the importance of prevention, risk factors, early recognition, and early initiation of appropriate therapy is important to reduce the morbidity due to infectious keratitis.

EPIDEMIOLOGY

Bacterial Keratitis :

Predisposing factors are trauma, vitamin A deficiency, low socioeconomic status and contact lens wear.

Mean annual incidence of bacterial keratitis is 5.3 per 1 lakh population with no statistically significant difference between men and women. There is a highly significant increase in risk with age. Bacterial keratitis is most commonly caused by gram positive organisms such as Staph. aureus. In tropical areas Streptococci and Pseudomonas may be predominant.

Contact lens wear is the most common cause in developed countries and is an important emerging cause in our part of the world too. Keratitis is more commonly seen with extended wear lenses than daily wear lenses. Risk factors for contact lens related keratitis include smoking, male sex and poor contact lens hygiene. Pseudomonas is the most common organism isolated

Fungal Keratitis :

Young men are predominantly affected by fungal ulcer and there is history of trauma in 54.4% cases. Children with fungal keratitis showed history of trauma in 55.3% cases. Cases are most common in

the monsoon season. Aspergillus and Fusarium are the most common pathogens (2).

PROTECTIVE BARRIERS AGAINST INFECTIVE KERATITIS (3)

1. Preocular tear film – immunoglobulins, complement components, enzymes like lactoferrin, lysozyme, betalysin, orosomucoid and ceruloplasmin. Mucin layer traps and removes pathogenic organisms.
2. Conjunctival subepithelial mucosal associated lymphoid tissue (MALT)
3. Langerhan's (dendritic) Cell in limbus and central cornea.
4. Intact epithelial layer which is the most important defence barrier.
5. Normal ocular flora provide a balance to prevent over growth of exogenous organism.

RISK FACTORS

1. Trauma is the most important risk factor in the form of epithelial abrasion, viral infection, toxic epithelial changes and contact lens wear. Injury with organic matter is more important in fungal keratitis.

2. Eyelid abnormalities like ectropion with exposure, entropion with trichiasis and lagophthalmos.
3. Tear film abnormalities including aqueous tear deficiency, mucin tear deficiency and meibomian gland disease.
4. Lacrimal drainage obstruction.
5. Inappropriate use of topical antibiotics.
6. Topical corticosteroid use causing localized immunosuppression.
7. Immunosuppression in children of 3 to 6 months age when the passive immunity is declining and active immunity is picking up, in diabetics and patients with AIDS.
8. Keratorefractive surgery and penetrating keratoplasty (Due to loose sutures, corticosteroid use, contact lens wear, persistent epithelial defects, graft failure)

BACTERIAL KERATITIS

Etiology

Four principal groups of bacteria are the most frequently responsible.

- Micrococcaceae (Staphylococcus, Micrococcus)
- The Streptococcus species.
- The Pseudomonas species.
- The Enterobacteraceae (Citrobacter, Klebsiella, Enterobacter, Serratia, Proteus).
- Rare causes – Actinomycetes, Nocardia, Mycobacteria, Clostridum, Propionibacterium, Spirochetes.

However any bacteria can cause keratitis under certain favourable conditions.

Factors that influence the type of bacterial keratitis are flora of the ocular surface, flora of the environment, ambient temperature and humidity, geographic location, chronic dacryocystitis (Pneumococcus), contact lens wear (Pseudomonas), vaccination (Low incidence of Corynebactrium & H.influenzae in infants), trauma, immuno-suppression as in AIDS (Pseudomonas) and consecutive keratitis.

Pathogenesis

Pathogenesis of ocular infections is determined by the intrinsic virulence of the microorganism, the nature of the host response and the anatomic factors of the site of infection.

Penetration of corneal epithelium requires a defect in the surface of the squamous epithelial layer. A few bacteria such as N.gonorrheae, N.meningitidis, Corynebactrium diphtheriae, Shigella and Listeria may directly penetrate intact epithelium by virtue of specialized enzymes and virulence factors.

Adhererence is important to colonise host cells. S.aureus uses adhesins to bind to collagen and other components of the exposed Bowman's layer and stroma. Ps. aeruginosa can bind to molecular receptors exposed on injured epithelial cells. Gonococcus uses glycocalyx which resists phagocytosis.

Proliferation of a clone of bacteria occurs within hours and invasion of cornea between the stromal lamellae.

Inflammation begins with the production of cytokines and chemokines that enable diapedesis and migration of neutrophils into

the peripheral cornea from the limbal vessels. Some microorganisms produce proteases that disrupt the extra cellular matrix. Enzymes released by neutrophils and activation of matrix metallo proteases (MMP) exacerbate inflammatory necrosis. Exotoxins and endotoxins play an important role.

Healing of wound begins with antimicrobial control of replication and is accompanied by neovascularization and scarring. Progressive inflammation may lead to perforation.

Clinical presentation

Patient with bacterial keratitis usually complain of pain due to the rich innervation of the cornea, decrease in vision, tearing, photophobia, blepharospasm and lateral lid edema. On examination there usually is an ulceration of the epithelium with suppurative stromal inflammation that may be focal or diffuse. There may be multifocal inflammation in polymicrobial keratitis, cellular infiltration of the adjacent stroma, anterior chamber cellular reaction ranging from mild flare and cells to severe layered hypopyon. Signs and symptoms may be less with prior antibiotic or corticosteroid treatment. Contact lens may cause multifocal, epithelial and stromal keratitis. Gram positive cocci cause localized, round or oval ulceration with greyish

white stromal infiltration having distinct border and minimal surrounding epithelial edema. Staphylococcus causes marginal infiltrative keratitis, peripheral ulceration, marked suppuration and deep stromal abscess, large hypopyon or endothelial fibrin plaque.

Streptococcus pneumoniae causes serpigenous ulcer, hypopyon, stromal abscess, Descemet's folds, stromal edema and retrocorneal fibrosis. Gram negative bacilli cause rapid paced inflammation with a destructive course. Serratia marcescens causes opportunistic infection in contact lens wearers.

Gonococcus causes hyperpurulent conjunctivitis with hyperemia, chemosis and stromal infiltration. Nocardia causes a chronic epithelial defect with calcification of the edge.

Differential diagnosis

HSV keratitis, neurotrophic ulceration, marginal ulceration, infiltrative keratopathy, toxic keratopathy, persistent epithelial and stromal keratopathy should be differentiated.

Assessment of severity

TABLE - 1

Severity Grading of Keratitis (Jones' Criteria)

Feature	Non Severe	Severe
Area of suppuration	<6 mm	>6 mm
Depth of ulcer	Superficial two thirds	Deeper third
Perforation	Unlikely	Present, imminent
Scleral suppuration	Absent	Present

Jones' criteria is used to assess the severity of keratitis. Slit Lamp photograph for documentation and monitoring and initial corneal topographic analysis may be necessary for documentation and monitoring .

Histopathological examination:

HPE discloses distinct stages of progressive infiltration, active ulceration, regression and healing.

Diagnosis

The reality is that the suggestive biomicroscopic appearance and clinical course alone are insufficient for definitive diagnosis. The

preponderance of clinical evidence raises the index of clinical suspicion, but laboratory diagnosis is required for confirmation of infection.

Laboratory diagnosis

Definitive culturing is the gold standard of clinical management. Gram stain, Giemsa stain, Flourescent Gram stain, Culturing , Antimicrobial susceptibility testing and Corneal biopsy are the recommended lab investigations. Ideally, samples for the microbiologic investigations of a suspected microbial keratitis must be collected before the start of any antibiotic treatment. Treatment can be initiated based on the result of the smears and, if required, modified in accordance with the culture and sensitivity results. The protocol essentially consists of four steps, viz: i) collecting, ii) transport, iii) processing of the clinical samples and iv) interpretation of the results.

Collection of samples

Despite recommendation for collection of a culture from the lids and conjuctiva of both the infected and the uninfected eye in several text books, samples from lids and conjunctiva have not yielded useful results in the management of corneal ulcers (4). Samples collected from the site of lesion, i.e. the infected corneal tissue are the most valuable for microbiological diagnosis of microbial keratitis. If available, any foreign

body on the cornea, contact lens, contact lens case, or lens solutions may be collected.

Corneal samples can be collected using the slit lamp or operating microscope after instillation of topical anaesthetic (4% Lignocaine hydrochloride or 0.5% Proparacaine hydrochloride). These anaesthetic agents may have variable effect on the growth of organisms, however, allowing some time interval between instillation of anaesthetic agent and collection of sample would help reduce their effect, if any.

Cotton swabs are not recommended for collection of corneal samples, however, calcium alginate swabs, if available, may be used in cases of bacterial keratitis. Platinum spatula, disposable blade(#15), bent needle, surgical knife and disposable cautery have all been used for collection of corneal scrapings for microbiological processing.

While collecting samples from the corneal ulcer the eyelids must be held widely apart to reduce inadvertent contamination by the lid margins or eye lashes. Adherent exudates on the surface of the ulcer may be removed using a sterile cotton swab prior to collection of scrapings.

The blade or spatula is scraped over the surface of the area of suppuration by a series of short, moderately firm strokes in one

direction to sample both the central and peripheral margins of the infiltrated area on the cornea. Each scraping is used to inoculate one medium or to prepare one smear. Viable organisms may be present throughout the inflamed area or localized to the advancing margin or the ulcer crater.

In the absence of accessible corneal suppuration, a corneal biopsy can be done with a disposable skin punch, diamond knife or small corneal trephine. Collection of anterior chamber exudates is advised only under exceptional circumstances.

Transport of corneal samples to the microbiology laboratory

Transportation of corneal scrapings in any transport medium is not recommended. The scrapings are plated directly onto culture media or smeared onto clean glass slides by the side of the patient in the clinic or operating room.

Processing of corneal scrapings

A complete microbiological workup may require upto 10 corneal scrapings for a number of smears and culture media. In case of a small ulcer, with limited material availability, high priority needs to be given to inoculation of blood agar or chocolate agar and to prepare only one or two smears.

Direct smear examination methods

Material is transferred from the blade / spatula to a glass slide over an area of approximately 1 cm in diameter within a wax-pencil marked (on the reverse) area to avoid needless searching under the microscope. While the specimen is thinly spread for dry smears (Gram, Giemsa, GMS) it can be just placed within the circle for wet smears (KOH, CFW, LPCB) under a cover slip. At least two smears should be prepared.

Table -2

Sequence of smear preparation and culture inoculation for the diagnosis of bacterial keratitis

Smears	1. Potassium hydroxide and / or Calcoflour White 2. Gram stain 3. Giemsa stain
Media	4. Blood agar – aerobic 5. Blood agar – anaerobic 6. Chocolate agar 7. Brain heart infusion broth 8. Thioglycollate broth 9. Non-nutrient agar 10. Sabouraud dextrose agar
Optional Smears / media	11. Potato dextrose agar 12. Lowenstein-Jensen medium 13. Brain heart infusion broth 14. Additional non-nutrient agar 15. Extra smear on slide

Culture methods

Inoculation - Agar plates such as blood sugar (BA), chocolate agar (CA), are inoculated by lightly streaking both sides of the blade / spatula over the surface in a row of separate C- shaped marks without penetrating the agar. The procedure helps distinguish valid growth from plate contaminants. Slopes of Sabouraud dextrose agar (SDA) or potato dextrose agar (PDA) in bottles are similarly inoculated by making a row of streaks form below upwards.

Incubation - The inoculated culture media are placed in appropriate incubators. All media are incubated at $35^{o}C$ except SDA and PDA which are kept at $27^{o}C$ in BOD incubator.

Observation - On solid agar plates growth on inoculation marks (C streaks) are regarded important while growth outside the inoculation marks are disregarded as contaminants. All culture media [except BA (anaerobic) in a jar / cabinet] must be examined daily for detection of any growth. BA (anaerobic) may be examined at intervals of 2-3 days for 2 weeks. Size, colour, texture, consistency and number of colonies on the inoculation marks are counted and recorded. An arbitrary semi- quantitative growth estimation is +(10 colonies), ++(10–15 colonies), and +++(50 colonies).

Identification - Bacterial colonies are usually Gram-stained and identified after consideration of colony characteristics, Gram-reaction, morphology and results of biochemical tests.

Identification of fungal species requires observation of rate of growth, colour, consistency and texture of the colony and characteristic microscopic features. Biochemical tests for identification are needed only in case of yeast or yeast-like fungal growth.

Interpretation of microbiological results

Smears

The results of smear examination form the basis for provisional diagnosis and initial choice of an antimicrobial agent.

The Gram-stain is useful in identifying bacteria, fungi, as well as Acanthamoeba cysts. Precipitated stain, carbon, salt crystals and necrotic debris can lead to troublesome artefacts in Gram-stained smears. It is easier to detect Gram-positive bacteria (especially S.pneumoniae) than Gram-negative bacteria. Gram variable bacteria may sometimes be seen. Fungal hyphae and Acanthamoeba cysts stain variably since their cell walls do not stain well and may often be seen as negative outlines. Giemsa-stained smear serves as a supportive smear.

Cytological details are seen well and bacteria, fungi as well as Acanthamoeba cysts can be seen.

Arbitrary quantification of bacteria per high power field may help determine the significance as bacteria comprising the indigenous microflora of the conjunctiva and tear film may be detected in small numbers. Smears with more than ten organisms are more determine. However, detection of bacteria in smears often needs to be correlated with corresponding bacterial growth in culture for determining significance. Failure of an organism, seen in smears, to grow in culture would indicate either non-viable organism or sample variation. Sampling error must always be ruled out in case of discrepant results.

Cultures

While smear examination provides preliminary evidence, culture isolation gives diagnostic confirmation. Culture report should indicate the day the growth appeared and its quantification or significance. Less than 10 colonies on only one solid medium or growth in only one liquid medium is usually equivocal. Growth of organisms such as S. epidermidis, Corynebacterium sp. and Propionibacterium sp. in small numbers or in a single liquid medium is

generally of uncertain significance. The same organisms, however, may be significant in the presence of a strong predisposing factor in the patient. All isolates must be considered in the light of clinical relevance and laboratory significance. Laboratory criteria for definitive infection include growth on two or more media, growth on at least one medium of the same organism identified in smears, confluent growth at the inoculation site on at least one solid medium, or repeat isolation from the same patient. These criteria are more applicable to bacteria and fungus than Acanthamoeba as it is neither a normal commensal nor a laboratory contaminant.

Antibiotic Susceptibility

Antimicrobial susceptibility testing is done in vitro to identify the response of an organism to a panel of selected drugs. Commercially available panels for Gram-positive and Gram-negative bacteria are used to determine sensitivity by disk-diffusion method. In this method (Kirby-Bauer) the bacteria is cultured on Mueller-Hinton agar, and antibiotic impregnated discs are applied. After incubation, the diameter of the zone of inhibition around each disc gives an approximation of susceptibility or resistance of the organism. Interpretation of agar

disk diffusion test for bacterial susceptibility that relates to levels of drug in serum is often controversial.

However, since higher antibiotic concentrations can be achieved in the cornea by topical administration of antibiotics, an organism labeled as resistant or intermediate in sensitivity by this test may respond to the drug in vivo. The reverse is unlikely to be the case.

The quantitative MIC can be compared to the antibiotic concentration expected at the site of infection. However, resistance breakpoints for ocular isolates have not been determined and there are no generally accepted cut off points.

Management

Currently no single antibiotic agent is effective against all bacterial species. Initial broad spectrum therapy is recommended until the offending organism is identified in culture.

If one type of bacteria is predominantly identified on a stained diagnostic smear treatment may initially be weighted towards the class of micro organism .

Broad spectrum therapy, however should not be eliminated as culture may reveal a diffuse class of micro organisms. Route of

administration of therapy should be based on severity of infection. Frequent (every 30 – 60 minutes) forified topical antibiotics are now used for bacterial keratitis. Fortified antibiotic solutions produce therapeutic antibiotic concentrations in the corneal stroma.

In severe cases, therapeutic stromal concentrations of antibiotic may be achieved more rapidly by initially administering the antibiotic drop every 5 minutes for 30 minutes as a loading dose. Subconjunctival and intravenous antibiotics in addition to frequent topical antibiotics are indicated in cases with suspected scleral and/or intraocular extension of infection.

Modification of initial antimicrobial therapy should be based on clinical response, not on the results of antimicrobial sensitivity testing. Determination of antibiotic sensitivity or resistance in traditional antimicrobial sensitivity tests is based on antibiotic concentrations achievable in the serum by oral or parenteral administration. Often, antibiotic concentrations greatly exceeding the mean inhibitory concentrations of bacteria are achieved in the corneal stroma following frequent fortified antibiotic administration.

Modification of antibiotic therapy in these cases should be based on antimicrobial sensitivity testing. Several clinical parameters are useful to monitor clinical response to antibiotic therapy:

- Blunting of the perimeter of the stromal infiltrate.
- Decreased density of the stromal infiltrate.
- Reduction of stromal edema and endothelial inflammatory plaque.
- Reduction in anterior chamber inflammation. Reepithelialization.
- Cessation of corneal thinning

The frequency of topical antibiotic administration should slowly be tapered as the stromal inflammation resolves.

Combination therapy with an agent active against gram positive bacteria (eg, vancomycin, bacitracin, neosporin, cefuroxime, or cefazolin) and an agent active against gram negative bacteria (eg tobramycin, gentamicin, amikacin, ceftazidime, ciprofloxacin, levofloxacin, or ofloxacin) provides good initial broad-spectrum antibiotic coverage. Single-agent therapy with a fluoroquinolone may

also be considered. These antibiotics should initially be given every 30 – 60 minutes and then tapered in frequency according to the clinical response. Fortified antibiotics should generally be continued until substantial infection control has been achieved. Thereafter, a broad spectrum, non fortified antibiotic may be given three to eight times daily according to the patient's clinical status.

Disadvantages of fortified antibiotics include ocular irritation, cost and the inconvenience of preparing a solution that is not commercially available. Their chief advantage is their potential to save vision in aggressive infections. Because second-generation fluoroquinolones such as ciprofloxacin and ofloxacin typically have variable activity against streptococci, documented streptococcal infections should be treated with a cell wall-active agent (eg.bacitracin cefazolin, vancomycin, or penicillin G) rather than a second-generation fluoroquinolone, regardless of in vitro testing that may suggest susceptibility. The fourth generation fluoroquinolones such as gatifloxacin may also be effective.

The role of corticosteroid therapy for bacterial keratitis is controversial. The antiinflamatory effects of corticosteroids must be

weighed against their effects of decreasing fibroblastic activity and inhibiting wound healing, thereby inviting corneal perforation.

Indications for surgical intervention would be disease progression despite therapy, descemetocele formation, perforation and poor response to antimicrobial therapy. While doing penetrating keratoplasty the involved area should be identified and circumscribed. Interrupted sutures are recommended. Intensive antibiotic, cycloplegic and corticosteroid treatment must be given postoperatively. Peripheral iridectomy can be done to compensate for seclusion of pupil.

FUNGAL KERATITIS

Prevalence of a fungal keratitis varies from region to region. In Chennai 45% was reported. In Madurai 52% was reported(5). In Karnataka 23% was reported. In India the most common fungal isolate is Aspergillus (27-64%) followed by Fusarium species (6-32%), Penicillium species (2-29%) and a number of other rare organisms (10-12%). Increased awareness of the occurrence and frequency of fungal keratitis, better recognition of the clinical features and improved laboratory techniques for direct examination of stained smears and culture of the causative fungi have all led to an increase in the frequency of correct diagnosis.

Etiology

Aspergillus and Fusarium species form the most common etiology for fungal keratitis. Others include Paecilomyces lilacinus, Pigmented fungi like Petriellidium boydii, Curvularia, Drechslera, Alternaria and Phialophora, Tropical fungi like Lasidiplodia, Colletotrichum and Candida albicans.

Risk Factors

Trauma with organic matter is the most common risk factor, others being similar to bacterial keratitis.

Clinical features

Fewer inflammatory signs and symptoms are seen than in bacterial keratitis. There may be no conjunctival injection on presentation.

Filamentary fungal keratitis is seen as a gray white, dry infiltrate having irregular feathery or filamentous margins. The ulcer may be elevated from the surface of the cornea and have a dry, rough or gritty texture detectable at the time of scraping. Occasionally multifocal or satellite infiltration, deep stromal infiltration with intact epithelium, endothelial plaque and immobile hypopyon may be seen.

On progression, intense suppuration may develop and the lesion may resemble bacterial keratitis. Rapidly progressive hypopyon and anterior chamber inflammatory membranes may develop. Occasionally fungus may invade the iris or posterior capsule and angle closure glaucoma may develop from inflammatory pupillary block.

Yeast keratitis presents as superficial, white raised ulcer. Deep suppuration may result resembling gram positive coccal keratitis.

Laboratory diagnosis

The details have been discussed under bacterial keratits.

Treatment

The initial drug of choice for either filamentous fungal or yeast keratitis is topical natamycin 5% suspension. The majority of isolates of Aspergillus, Cephalosporium, Curvularia, Fusarium, and Candida are susceptible in vitro and do not acquire resistance to natamycin. Unlike other polyenes, natamycin is relatively stable in suspension at room temperature and is nonirritating to the conjunctiva and cornea following topical application. Natamycin is not absorbed from tissue and produces necrosis and granulomata following injection.

Oral flucytosine (150 mg / Kg / day) produces aqueous levels of drug in excess of 40 mg / ml and may contribute to control of deep stromal suppuration or endophthalmitis caused by susceptible fungi.

Clinical impression dictates the decision of initial therapy of non severe keratitis in the absence of detectable organisms in the corneal smear.

TABLE - 3 Recommended doses of available topical and subconjunctival antimycotics		
Antimycotic	Topical	Subconjunctival_
Amphotericin B	1.0-2.5 mg / ml	0.5-1.0 mg
Natamycin	50 mg / ml	
Nystatin	5,000 units/ml	
Miconazole	10 mg/ml	5-10 mg
Ketoconazole	10-20 mg/ ml	
Fluconazole	2 mg / ml	
Voriconazole	10 mg / ml	
Flucytosine	10 mg / ml	

Apart from specific antibacterial and antifungal treatment, lacrimal sac should invite attention and be properly managed if there is infection.

Cycloplegics are a must to alleviate pain due to ciliary spasm and to treat associated iritis if any.

Prevention

The greatest risk factor for corneal ulceration is corneal abrasion. Only 65% of all patients with corneal ulcers could remember having a prior abrasion, but this percentage is probably low because of recall bias. Both fungal and bacterial ulcers that occur following traumatic corneal abrasion can be effectively prevented in a village setting by using relatively simple measures that local volunteer public health workers can be easily taught to employ (6,7).

This emphasizes the need for health education to prevent avoidable blindness due to corneal trauma by creating awareness of primary eye care following trauma.

REVIEW OF LITERATURE

Whitcher JP, Srinivasan M, Upadhyay M(8) in Int ophthalmol Clin 2002; 42:71-7 have reported that epidemiology of corneal blindness varies from country to country and population to population depending on various risk factors.

Thylefors B and Whitcher JP et al. (9,10) have reported corneal trauma as the major risk factor for corneal ulceration.

Srinivasan M et al (2) and Upadhyay MD (6) have reported that majority of minor trauma leading to corneal ulcer was sustained during agricultural work or in the home. Pahalkar and associates (2) in South India and Carmichael, Wolparp and Koornhof (11) in South Africa have reported Streptococcus pneumoniae as the most frequently isolated bacterial pathogen in corneal ulcer.

Jones B.R (12) reported Aspergillus as the most commonly isolated Fungus from corneal ulcer. Kamlesh et al. (13) have reported Staph. aureus as the commonest cause of galloping corneal ulcer(16%).

Mc Donnell et al., found that cultures were obtained only for approximately 50% of corneal ulcers by community ophthalmologists

and that approximately 60% of these cultures were obtained with cotton tipped applicator and sent for laboratory studies in a transport medium alone.

A review of recently published textbooks of corneal diseases offers consensus on evaluating and treating suspected infectious keratitis. Regardless of the apparent stage and severity of the suspected infection, scrapings for Gram stain and culture are mandatory, and changes in therapy should be informed, whenever possible, by the results of these laboratory studies(14,15,3,16,17).

Jules Baum, MD, Michael Barza, MD, (18) have established the equal efficacy of topical and subconjunctival treatment of bacterial corneal ulcer.

Davis et al. found that topical therapy was more potent than subconjunctival or parenteral injection of antibiotics(19).

This was true when the therapy was started early (20), when drops were applied frequently (21), in highly concentrated form and when the cornea was deepithelialized.

Kupferman and Liebowitz (22) and Liebowitz et al. (23) demonstrated efficacy of topical therapy in experimental corneal infection.

Arffa (15) states, “Every ophthalmologist should be equipped to take adequate scrapings of the ulcer”.

Ostler and Ostler (14) state in their text, “in all cases except those that are obviously due to HSV infection, laboratory studies are mandatory”.

Ogawa and Hyndiuk (3) state, “A microbiologic work up of a suspected infectious ulcer must be done before the start of any antibiotic treatment”.

Stephen D.Mcleod have reported that in general, ophthalmologists forgo scrapings for ulcers that appear less severe for which justification should be established.

Wilhelmer KR et al. (20) found that culture confirmation affects the antibacterial therapeutic response rate of ulcerative keratitis and, while not modifying the comparative effect of equivalent antibacterial treatments, facilitates generalizability of clinical trials of bacterial keratitis.

Leisegang and Forster (24) retrospectively reviewed 9 years of stain and culture data from 663 corneal ulcers and concluded that blood agar incubated at $37^{o}C$ appeared to be most useful for recovery of bacterial pathogens.

Evan Waxmam et al. (25) reported that chocolate agar grew fungi better than blood agar and was the most ideal single culture medium for microbial ulcer.

There is almost universal agreement among specialists in external diseases of the eye that the Gram stain characteristics and the morphology of bacteria should decide the initial selection of antibiotics in the treatment of bacterial corneal ulcers (26,27,28,29).

Jules L.Baum (30) has suggested that the initial treatment of bacterial ulcers of the cornea should consist of a combination of antibiotics that are effective against the major pathogens in the community. A gram stain may be misleading and therefore may suggest inappropriate therapy. Antibiotic therapy should include subconjunctival injections and fortified eye drops, but not systemic administration except following perforation.

Antibiotic therapy should be changed only if the pathogen is reported to be resistant to initial therapy AND if the corneal ulcer continues to worsen.

Jones DB (31) has recommended initial evaluation of infectious keratitis as severe and non severe. Severe ulcer is defined as one with rapid progression, >6 mm in diameter, involving the inner 1/3 rd of

the cornea, perforation imminent or present, and presence of suppuration. He suggests that initial therapy must be based on the results of the corneal smears in conjunction with the assessment of the severity of the keratitis.

Pragya Parmar et al. (21) reported a significantly better action of Gatifloxacin against grampositive cocci both in vitro and in vivo when compared with ciprofloxacin.

Safiye Yilmaz MD et al. (32) have reported that subconjunctival fluconazole could be effective for treatment of severe fungal keratitis with hypopyon and could be very useful to avoid surgical intervention at an acute stage of this infection.

N. Venkatesh Prajna et al. (7) have emphasized the need for health education to prevent avoidable blindness due to corneal trauma by creating awareness of primary eye care following trauma.

AIM OF THE STUDY

To study the epidemiologic characteristics, risk factors, etiology, relevance of gram stain and culture, response to treatment and outcome of microbial keratitis in the general adult population.

MATERIALS AND METHODS

This was a prospective, nonrandomized, analytical clinical Study conducted at the Cornea clinic, Department of Ophthalmology, Madurai Medical College Hospital between August 1, 2006 and July 31, 2007. All patients presenting with suspected microbial keratitis during the study period were examined according to a dedicated corneal ulcer protocol.

Inclusion criteria were

1) Presence of corneal stromal infiltration on slit-lamp examination and
2) Microbiological investigations of corneal ulcer scraping.

Exclusion criteria were

1. Viral keratitis,
2. Keratitis of non infective etiology
3. Children below 16 years of age.

Examination was conducted at the cornea clinic as per a dedicated protocol. History taking included information about the duration of symptoms, prior treatment, predisposing ocular conditions and associated risk factors like trauma and diabetes mellitus.

All patients were examined at the slit lamp biomicroscope. Corneal ulceration was defined as loss of the corneal epithelium with clinical evidence of infection with or without hypopyon. The size of the ulcer was measured using the variable beam on the slit lamp or by using a millimeter ruler. In a similar fashion, the size and depth of stromal infiltration were recorded. Clinical sketches of frontal and cross sectional views and associated hypopyon were noted on the form. Predisposing ocular conditions including dacryocystitis, dry eye, corneal anesthesia, and blepharitis were looked for.

The corneal ulcers were sized as small (< 5 mm), medium (5 – 7mm) and large (> 7 mm).

Using standardized techniques, corneal ulcer scrapings were obtained using the back of a sterile 11 blade and inoculated directly onto 5% sheep blood agar and Sabouraud dextrose agar. Scraped material was also subjected to direct microscopy after staining with Gram stain and Lactophenol cotton blue. Growth in culture was deemed significant if the same organism was isolated on atleast two "C" streaks of one culture medium with consistent morphology on direct microscopy. Antibacterial sensitivity testing was performed using Kirby Bauer disk diffusion method.

For bacterial keratitis, ofloxacin (0.3 %) hourly was the first line of therapy. If clinical response was unsatisfactory, antimicrobial therapy was changed either by adding fortified cefazolin (5.0%) and tobramycin (0.3%) or as per culture and sensitivity reports.

For fungal keratitis, natamycin (5%) suspension was the preferred first line of treatment. If clinical response was inadequate fluconazole (0.2 %) or itraconazole (2%) eye drops were added to the treatment regimen. Oral ketoconazole (200 mg bid) was added in cases of severe keratitis and non responders.

Statistical analyses were performed using Excel Worksheets (Microsoft Corporation, Redmond, WA)

RESULTS

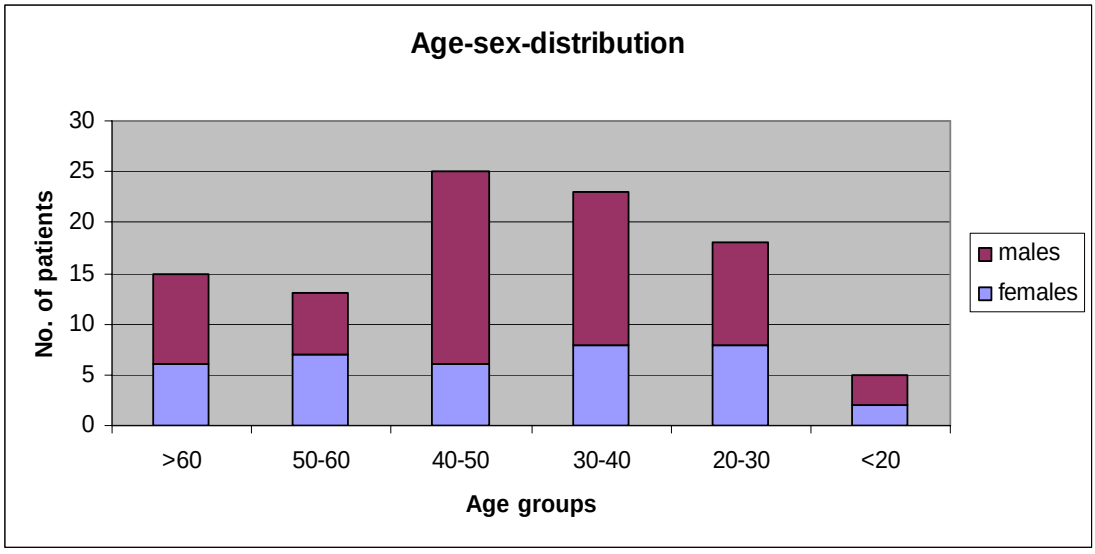
1) Patient Demographics

Details of the number of patients, sex distribution and the age groups are listed in Table 1 and chart 1.

TABLE – 1 AGE-SEX DISTRIBUTION

Age distribution	Females	Males
>60	6	9
50-60	7	6
40-50	6	19
30-40	8	15
20-30	8	10
<20	2	3

CHART-1



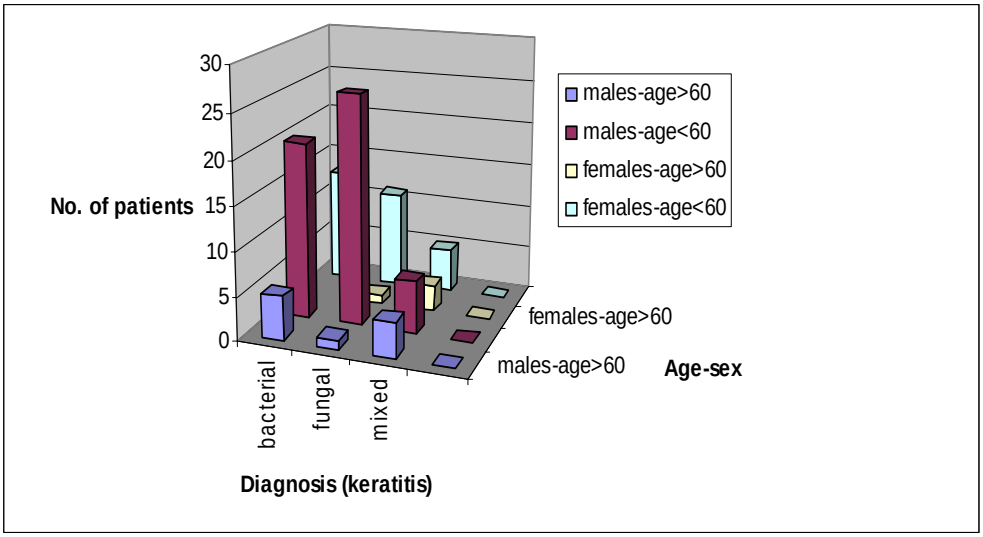
Of the 100 patients, 82 were below 60 years and 18 were above 60 years of age. In the young age group 52 were males and 30 were females. In the old age group 10 were males and 8 were females. The Total numbers of male patients was 62 and female patients was 38.

The incidence was maximum in the 40-50 years age group. The age wise sex distribution is shown in Chart 1 & 2 and Table 1 & 2.

TABLE - 2

	Bacterial	Fungal	Mixed
Males-age>60	5	1	4
Males-age<60	20	26	6
females-age>60	5	1	3
Females-age<60	13	11	5

CHART-2



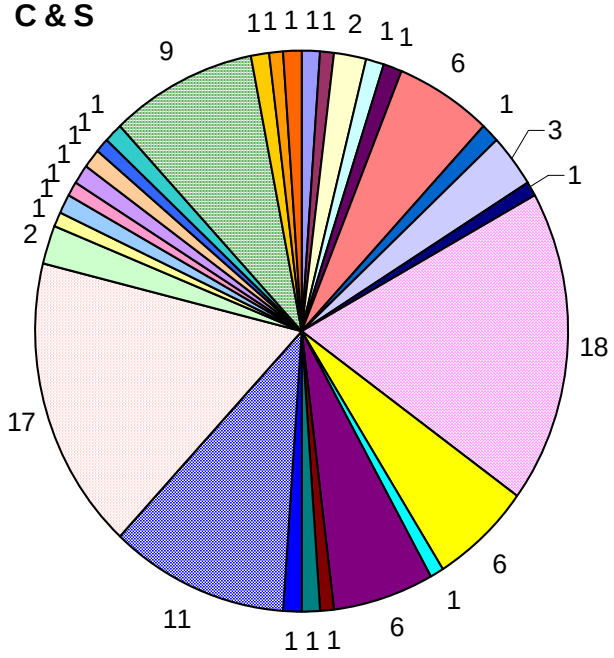
2) Microbiological Features

Culture was positive in 77 cases of which 36 were bacterial and 22 were fungal and 19 were mixed. The specific organisms isolated from the culture positive cases are detailed in Table 3 and Chart 3. In the younger age group, there was no significant difference between the incidence of bacterial and fungal keratitis.

TABLE - 3

DIAGNOSIS	C&S	TOTAL
Bacterial	Acinetobacter spp	1
	Beta hemolytic streptococcus	1
	Enterobacter spp	2
	Escherichia coli	1
	Escherichia coli+ Staphylococcus aureus	1
	Nil	6
	Non hemolytic Streptococci+ Enterobacter sp	1
	Pseudomonas aeruginosa	3
	Pseudomonas aeruginosa+ nonhemolytic strep	1
	Staphylococcus aureus	18
	Streptococcus pneumoniae	6
	Streptococcus pyogenes	1
Bacterial Total		42
Fungal	Aspergillus flavus	6
	Aspergillus flavus+ Staphylococcus aureus	1
	Aspergillus fumigatus	1
	Candida albicans	1
	Fusarium solani	11
	Nil	17
	Staphylococcus aureus	2
Fungal Total		39
Mixed	Aspergillus fumigatus+Staph.aureus	1
	Coag negative Staph,Klebsiella pneumoniae	1
	Enterococcus fecalis	1
	Escherichia coli	1
	Fusarium solani	1
	Non hemolytic Streptococci	1
	Pseudomonas aeruginosa	1
	Staphylococcus aureus	9
	Staphylococcus aureus, Fusarium solani	1
	Staphylococcus aureus+Aspergillus flavus	1
	Staphylococcus aureus+Escherichia coli	1
Mixed Total		19
Total		100

DIAGNOSIS C & S



Acinetobacter spp	Beta hemolytic streptococcus
Enterobacter spp	Escherichia coli
Escherichia coli+ Staphylococcus aureus	Nil
Non hemolytic Streptococci+ Enterobacter sp	Pseudomonas aeruginosa
Pseudomonas aeruginosa+ nonhemolytic strep	Staphylococcus aureus
Streptococcus pneumoniae	Streptococcus pyogenes
Aspergillus flavus	Aspergillus flavus+ Staphylococcus aureus
Aspergillus fumigatus	Candida albicans
Fusarium solani	Nil
Staphylococcus aureus	Aspergillus fumigatus+Staph.aureus
Coag negative Staph,Klebsiella pneumoniae	Enterococcus fecalis
Escherichia coli	Fusarium solani
Non hemolytic Streptococci	Pseudomonas aeruginosa
Staphylococcus aureus	Staphylococcus aureus, Fusarium solani
Staphylococcus aureus+Aspergillus flavus	Staphylococcus aureus+Escherichia coli

Of the total 44 bacterial isolates 29 were gram positive and 15 were gram negative. Staplylococcus aureus was the most commonly isolated bacteria in the series accounting for 20% of all positive bacterial cultures. The next most common gram positive organism was Streptococcus pneumoniae (14%). This was followed by Pseudomonas aeruginosa (6%), Enterobacter (5%) and non hemolytic streptococci (2%).

Pseudomonas aeruginosa was the most frequently isolated gram negative bacterium, accounting for 20% of the positive cultures.

This was followed by Enterobacter and E.Coli. The number of gram stained smears and their positivity and negativity are shown in table 4.

In the fungal positive cultures (37), fungal elements were demonstrated in direct corneal smears from 20 of the patients.

TABLE-4

Gram stain	Positive	Negative
True	72	18
False	4	6
Total	76	24

Sensitivity = 94.7% Specificity = 25%

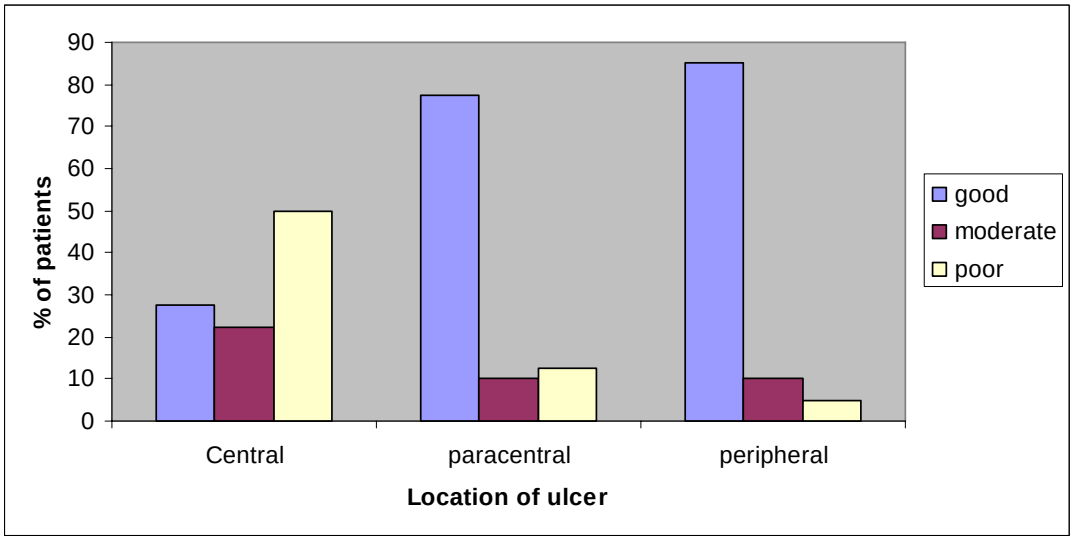
3) **Clinical examination**

The location of the ulcers and their visual outcome is shown in Table 5 and chart 5.

TABLE-5

LOCATION	**Total**	Good(%)	Moderate(%)	Poor(%)
Central	40	11(27.5)	9(22.5)	20(50)
Paracentral	40	31(77.5)	4(10)	5(12.5)
Peripheral	20	17(85)	2(10)	1(5)
Grand Total	100			

CHART-5



The visual outcome in the various sized ulcers and those with and without hypopyon is shown in Table 6, Table 13.

TABLE - 6

HYPOPYON	VISUAL OUT COME	Total
-	Good	52
	Moderate	8
	Poor	10
- Total		70
+	Good	7
	Moderate	7
	Poor	15
+ Total		29
Grand Total		**99**

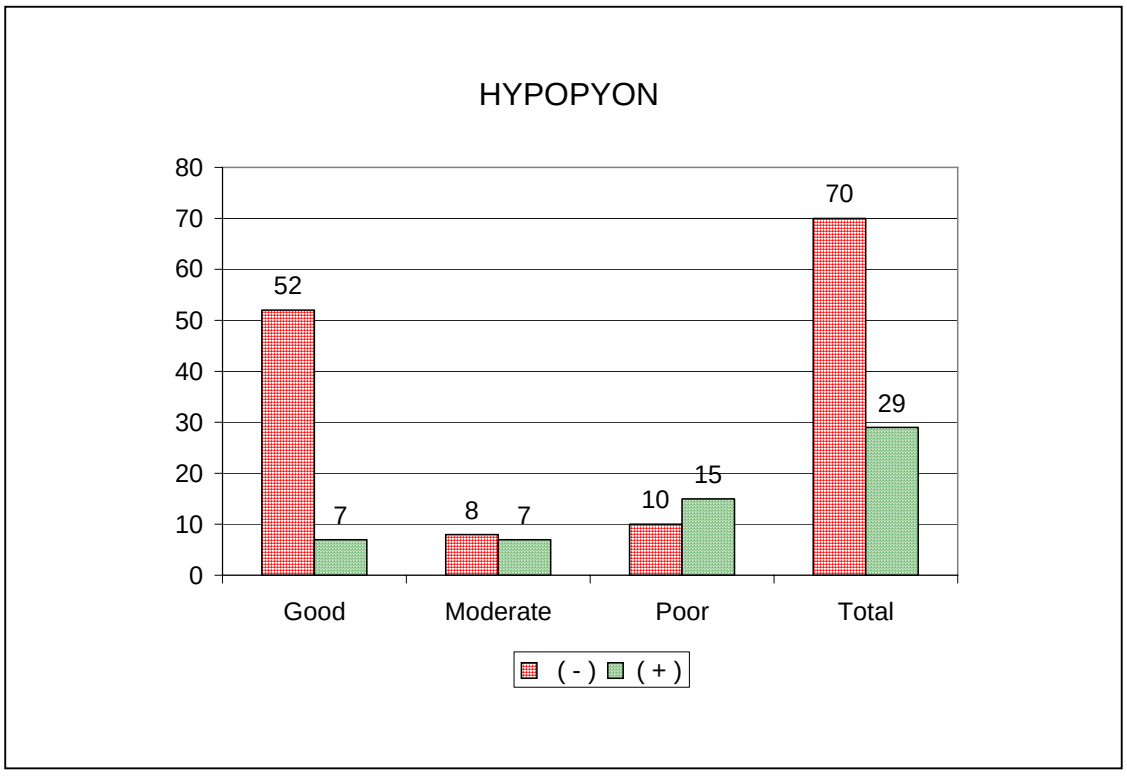
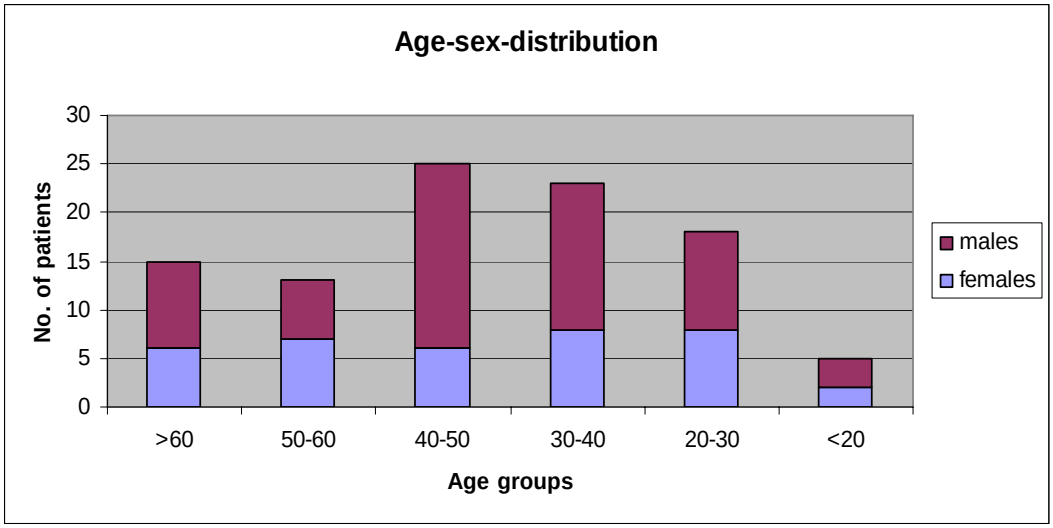


TABLE – 7

	Large	Medium	Small
Elderly >= 60 Years	2	9	7
Younger < 60 Years	7	28	47



The sensitivity pattern of the isolated organisms with their percentage susceptibility to the commonly used topical and fortified antibiotics is given in Table 8

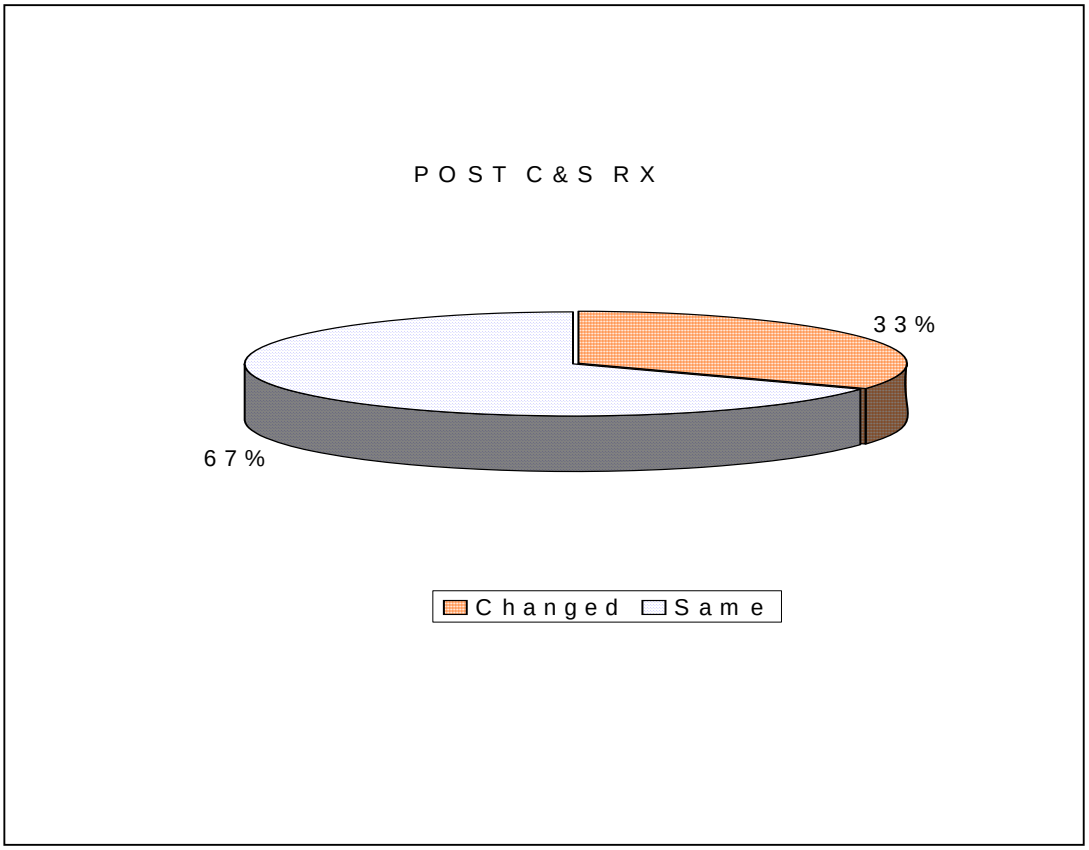
TABLE -8

Antibiotic Organisim	Gati	Cipro	Oflox	Zolin	Taxim	Zidim	Amik	Tobra	Genta
Staph.aureus (34)	100 (34)	100 (34)	100 (34)	100 (34)	100 (34)	100 (34)	100 (34)	100 (34)	95 (27)
B hemolytic Strep. (1)	100 (1)	100 (1)	100 (1)	100 (1)	0	0	0	0	0
Non hemolytic Strep. (3)	100 (3)	100 (3)	100 (3)	66 (2)	66 (2)	66 (2)	0	33 (1)	0
Str. pneumoniae (6)	100 (6)	30 (2)	50 (3)	60 (4)	100 (6)	30 (2)	60 (4)	50 (3)	30 (2)
Pseudo monas (5)	100 (5)	100 (5)	100 (5)	0	60 (3)	100 (5)	100 (5)	100 (5)	100 (5)
E. Coli (4)	50 (2)	25 (1)	50 (2)	50 (2)	0	100 (4)	100 (4)	50 (2)	50 (2)
Enterobacter (3)	100 (3)	100 (3)	100 (3)	0	60 (2)	60 (2)	60 (2)	100 (3)	60 (2)
Kleb. Pneumoniae (1)	100 (1)	100 (1)	100 (1)	100 (1)	100 (1)	100 (1)	100 (1)	100 (1)	100 (1)
Acineto bacter (1)	100 (1)	100 (1)	100 (1)	0	100 (1)	100 (1)	100 (1)	100 (1)	100 (1)
Enterococcus (1)	100 (1)	100 (1)	100 (1)	100 (1)	0	0	0	0	0
Gram +ve	100	82.5	87.5	81.5	66.5	49	40	45.75	31.25
Gram -ve	91.6	87.5	91.6	41.6	53.3	76.6	76.6	75	68.3
Total	95.8	85	89.55	61.5	59.9	62.8	58.3	60.3	49.7

33 patients required change of treatment after the culture and sensitivity reports as in table 9.

TABLE - 9

POST C&S Rx	**Total**
Changed	33
Same	67
Grand Total	**100**



4) Predisposing factors:

The predominant predisposing factor was trauma. The various injuries are listed in table 10.

TABLE - 10

INJURY	**Total**
-	48
?	1
? neurotrophic	1
Birddropping	1
Cement	1
Contact lens	2
coconut shell	1
cow's tail	2
Dust	7
Foreign body	14
Fly	1
Grass	1
Onion	1
onion peel	1
prior HZO	1
Sand	2
Sandal powder	1
shikakai powder	1
soapnut powder	1
soft contact lens	1
Stick	5
Stone	1
Straw	1
Sugarcane	1
Thorn	1
Vegetable matter	1
wood powder	1
Grand Total	**100**

The other predisposing factors were neurotrophic keratitis, viral infection, diabetes and chronic dacryocystitis (Table 11 & 12).

TABLE - 11

DIABETES	**Total**
-	95
+	5
Grand Total	**100**

TABLE-12

NLD	**Total**
Patent	97
Regurg	3
Grand Total	**100**

5) Outcome:

Follow up was for a mean of 30 days.

The visual outcome was good in 59 eyes, moderate in 15 eyes and poor in 26 eyes. The visual outcome based on the size of ulcer is shown in Table 7. The visual outcome based on the location of ulcer is shown in Table 5. The visual outcome in relation to hypopyon is given in Table 6.

The incidence of poor visual outcome (< 6/60) in the elderly age group was significantly higher compared to the younger age group.

DISCUSSION

1) Patient Demographics

Most large age–independent series of microbial keratitis report a male preponderance of 61% to 71%. In this study, 62% of ulcers occurred in males. 59.52% of bacterial ulcers, 69.23% of fungal ulcers and 55.55% of mixed ulcers occurred in males. The age group affected maximum by corneal ulcer was the 40 to 50 years age group.

Male preponderance was more in the younger age group (63.41%) than in the elderly age group (55.55%) similar to the study by Pragya Parmar et al.(33) who have reported 60%. This is probably due to the increased chances of injury in the male population.

2) Microbiological features

The prevalence of different organisms responsible for microbial keratitis varies in different parts of the world. In a large series in India, Nepal and Bangladesh, fungi caused 20% to 60% of all infectious keratitis cases (34,35,36). In a study at Joseph Eye Hospital, Trichy by Pragya Parmar et al (33), an incidence of 56.1% was reported.

In this study, the incidence of bacterial keratitis is 42%, fungal keratitis is 39% and mixed ulcers is 18%. This is similar to other reported series from this part of the world (33,34,35,36).In this study, gram–positive cocci (especially Staphylococcus aureus and Streptococcus pneumoniae) and filamentous fungi (Fusarium and Aspergillus) accounted for most of the bacterial and fungal keratitis, respectively. This is similar to the earlier reports (33,34,35,36).

Gram positive cocci accounted for 28% of all microbial keratitis in this study. In a large series of cases of microbial keratitis from another center in Southern India (31) Staphylococcus epidermidis (31.1%), filamentous fungi (15.7%), Corynebacterium species (16.3%), Pneumococci (13.5%) and Pseudomonas (13.5%) were the leading etiological microbes.

Yeast-like fungi (Candida) accounted for 5% of the total fungal isolates. This is similar to reports in earlier studies by Jones DB (21).

Gram stains showed 95% true positives and 75% true negatives which show the high sensitivity of microscopy of gram stained smears. This makes it a reliable screening test rather than a confirmatory test. Hence all positive and negative gram stained samples must be subjected to culture and sensitivity to confirm

etiological diagnosis. The value of gram staining of smears lies in choosing the initial antibiotic treatment. Since 33% of patients required change in initial therapy following culture and sensitivity reports, it is mandatory to obtain scrapings before the initiation of antibiotic therapy.

Culture confirmation, while not modifying the findings of recent clinical trials of microbial keratitis, provides a gold standard that allows antibacterial comparisons to be generalized. Corneal cultures provide the basis for understanding the epidemiology of bacterial keratitis.

Culturing allows ocular microbiologists to identify shifting patterns of responsible microorganisms and to detect emerging resistance. The sensitivity pattern of the various bacterial isolates to the commonly used topical and fortified antibiotics reveals results as follows. Though sensitivity was tested for 54 antibiotics the commonly used topical gatifloxacin, ofloxacin, ciprofloxacin and tobramycin and fortified cefazolin, cefotaxime, ceftazidime, amikacin and gentamicin were tabulated. All Staphylococcus aureus cultures were sensitive to all the antibiotics except gentamicin for which sensitivity was 95% . Of the Pneumococci, 100% were sensitive

to gatifloxacin and cefotaxim, 60% were sensitive to cefazolin and amikacin, 50% were sensitive to ofloxacin. Of the non hemolytic streptococci, 100% were sensitive to fluoroquinolones, 66% were sensitive to fortified cefalosporins, 33% were sensitive to tobramycin and all were resistant to amikacin and gentamicin. Of the Beta hemolytic streptococci, 100% were sensitive to fluoroquinolones and cefazolin and resistant to other antibiotics. Of the Pseudomonas aeruginosa isolates, all were sensitive to fluoroquinolones, aminoglycosides and ceftazidime and 50% were sensitive to cefotaxim and all were resistant to ceftazidime. Of the E.coli, all were sensitive to ceftazidime and amikacin, 50% were sensitive to gatifloxacin, ofloxacin, cefazolin, tobramycin and gentamicin, 25% were sensitive to ciprofloxacin and all were resistant to cefotaxim. The single Enterococcus isolate was sensitive to all quinolones and cefazolin and resistant to the other antibiotics.

Hence, there was an average sensitivity of 100% to gatifloxacin, and less to the other antibiotics among the gram positive cocci.

There was an average sensitivity of 62.8% to ceftazidime and amikacin and 91.6% to gatifloxacin and ofloxacin and less to other antibiotic among the gram negative bacteria.

The overall sensitivity percentage of all bacterial isolates was 95.8% for gatifloxacin, 89.55% to ofloxacin and less for all other antibiotics.

Thus gatifloxacin (0.3%) is the antibiotic of choice for initial monotherapy of microbial kertitis. When gram negative bacilli are identified on gram stained smear of the corneal scrapings it is rational to add fortified amikacin or ceftazidime to gatifloxacin and await culture and sensitivity reports.

3) **Clinical examination**

In this study, the incidence of central ulcers was 40%, paracentral ulcers was 40% and peripheral ulcers was 20%. Small ulcers constituted 54%, medium sized ulcers 37% and large ulcers 9%. The visual outcome was poor in all cases with large ulcers, 8% of small ulcers and 30% of medium sized ulcers.

The visual outcome was poor in 50% of central ulcers, 12.5% of paracentral ulcers and 5% of peripheral ulcers. This incidence of

large and central ulcers was 11% and 50% in the old age group. It was 8.53% and 37.8% in the younger age group. This explains the significant poorer visual outcome in the elderly age group.

4) Predisposing factors

The most common predisposing factor was trauma in both age groups. Other studies have also reported trauma to be the major predisposing factor in age-independent series of keratitis (5,36). The commonest traumatizing agent was organic material (45%), foreign body(30%), dust 15%, contact lens 6% similar to other large series (5,36).

Associated ocular disease trailed behind trauma as the most common predisposing factor. This difference probably reflects the large proportion of people engaged in farming activity (47%) in this series.

The majority of patients (46%) were agricultural labourers, 26% were homemakers, 10% were students, 11% were office workers and 7% were other labourers. This is consistent with reports by Srinivasan M et al (5) and Upadhyay MD et al (6) who have reported farmers and home makers as the most vulnerable to corneal trauma.

5) Outcome

The overall visual outcome in this series was good (>6/18) in 59% of eyes, moderate in 15% of eyes and poor in 26% of eyes. This is more favourable compared to a study by Parmar et al (33) who have reported 50% of cases with good visual outcome (>6/18) and Kunimoto et al (37), who reported 36.4% and Vajpayee et al, 22% had a final visual activity of 20/60 (38). The large proportion of non severe ulcers in this series probably accounts for these good results. In this series, 26 ulcers ended in a poor visual outcome of which 9 (34.6%) were above 60 years of age, 5 (19.2%) were large ulcers, 15 (57.7%) were central ulcers. Staphylococcus caused 7 (26.9%), Fusarium 3 (11.5%), Pseudomonas 3 (11.5%), Pneumococcus 2 (7.7%) those ulcers with poor visual outcome. There were 4 small ulcers which had a poor visual outcome of which 2 (50%) were caused by Pneumococcus. 9 of the 18 elderly patients (50%) had poor outcome, while 17 of the 82 younger patients (20.7%) had poor outcome. The final visual outcome was significantly worse in the elderly age group. Hypopyon was seen in 30 cases out of which visual outcome was poor in 15 (50%).

Outcome was poor in 10 (14.28%) of cases without hypopyon (70%). The probable factors for poor visual outcomes in the 26 cases

in this series are old age, large size, Streptococcus pneumoniae, Fusarium solani and the presence of hypopyon. Probably the high incidence of poor visual outcome reflects the higher incidence of severe ulcers and central ulcers in the elderly that in turn is probably related to poor immunocompetence in this age group rather than to a delay in seeking therapy. The presence of other associated ocular pathology such as cataracts also possibly contributes to poor visual outcome in these patients.

The importance of this type of survey has great meaning in the context of the limited health care resources available for the diagnosis and treatment of diseases that cause blindness in many of the developing countries of the world. The rationale for purely empirical therapy of suspected bacterial keratitis is to achieve a high proportion of success with a chosen antibiotic regimen, regardless of the identity of the causative organism. Certainly, a practice will save money if it does not maintain Gram stain and culture supplies. It will reduce the time spent in the initial evaluation of the patient if scrapings are not taken and smear not examined. Laboratory fees will be eliminated if cultures and their interpretation are deferred. If the ulcer heals without adverse sequelae, this approach represents substantial

savings. However, treatment failures are expected to generate increased costs in terms of patient well being and therapeutic intervention.

This study showed that gatifloxacin (4^{th} generation fluoroquinolone) and ofloxacin (2^{nd} generation fluoroquinolone) had a significantly better action against gram positive cocci as well as a good percentage of gram negative bacilli when compared with ciprofloxacin. Because gram positive cocci are the leading cause of keratitis world wide, this suggests that gatifloxacin should replace ciprofloxacin as first line monotherapy in bacterial keratitis.

CONCLUSION

1) There is a significant male preponderance in microbial keratitis both bacterial and fungal especially in the younger age group.
2) The most vulnerable age group is 40-50 years of age.
3) The most common risk factor for infectious corneal ulcer is trauma of which the most common is with organic matter and foreign body.
4) Agricultural labourers are the most susceptible, the next common being home makers.
5) The factors that lead to poor visual outcome are age above 60 years, large ulcers, hypopyon, central ulcers and when Pseudomonas species, Pneumococcus or Fusarium species are isolated from the ulcer. Pneumococcus is a significant risk factor even when the ulcer is small.
6) Gram staining of the corneal scrapings is a sensitive test and may be used as a screening test and to start initial empirical therapy.

7) It is mandatory to subject the corneal scrapings from all suspected microbial keratitis to culture and sensitivity on blood agar plate and Sabouraud's dextrose agar and directly inoculate the media at the time of scraping rather than using transport media.

8) Topical gatifloxacin (0.3%) is the antibiotic of choice for initial monotherapy of bacterial keratitis.

9) Fortified amikacin (20mg/ml) or fortified ceftazidime (50mg/ml) must be added to gatifloxacin 0.3% if gram negative bacilli are identified on gram stained smears.

10) Modification of initial antibiotic is needed only when worsening of the ulcer occurs clinically.

11) Prevention of corneal ulcers can be achieved by protective eyewear at work and prompt treatment of corneal injury at the primary health care level combined with health education to create awareness regarding early treatment of corneal trauma.

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PROFORMA

Name: Age/Sex: Date:

Address: Occupation:

Ph:

Diagnosis

C/o & duration

H/o similar episodes in the past
Medical illness DM/ HT/ HIV
Ocular disease
Injury with vegetable matter

GE:

Visual acuity:

SLE: OD OS

Corneal ulcer:
Size - mm; (small/ medium/ large)
Location - Central/ peripheral
Edges
Base
Hypopyon - Ppresent/ absent

Complications -

Clinical diagnosis-

Microbiology – KOH prep. –
Gm Stain -
Culture and sensitivity –

Initial treatment –

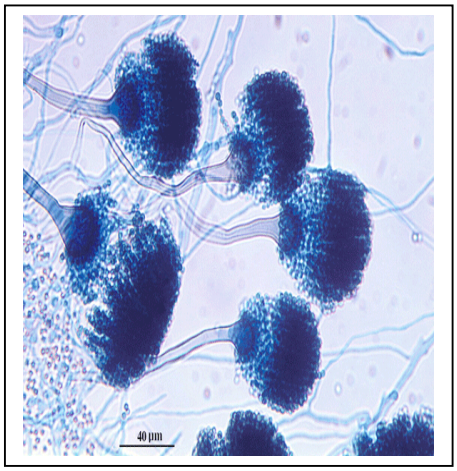
Treatment after C&S report –

Visual acuity after

Ulcer details

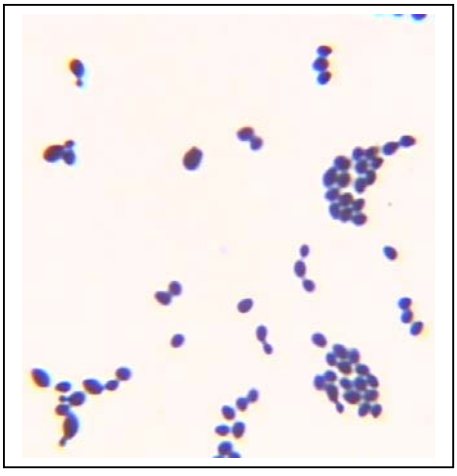
- Small/ medium/ large
- Culture +/-
- Response to initial Rx
- Visual outcome

ASPERGILLUS FUMIGATUS



ASPERGILLUS FUMIGATUS CULTURE

CANDIDA

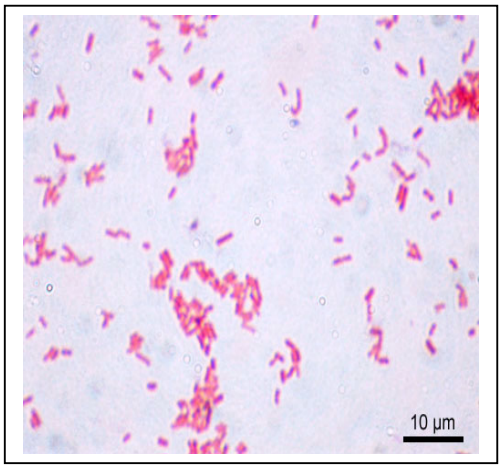


CANDIDA CULTURE

ENTEROCOCCI

ENTEROCOCCI
CULTURE

ESCHERICHIA COLI
GRAM STAIN



ESCHERICHIA COLI
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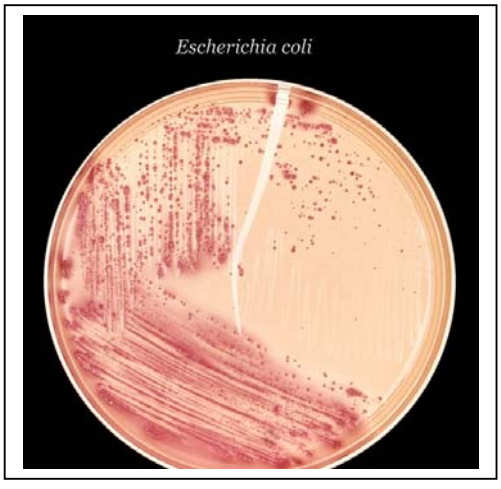
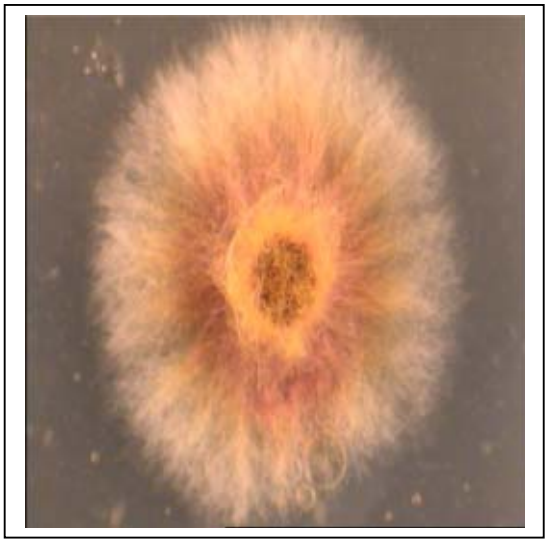
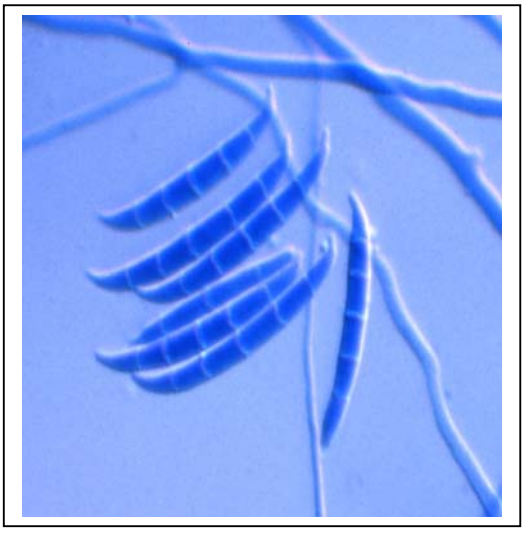


FUSARIUM

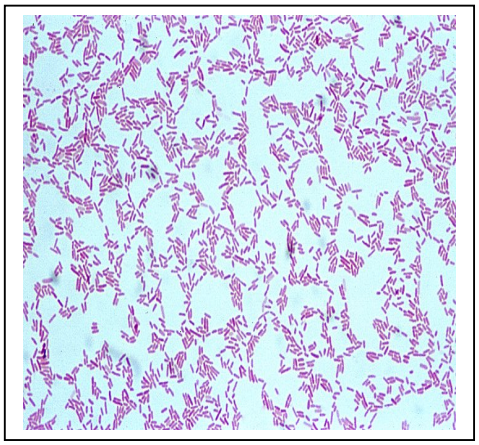
FUSARIUM CULTURE



FUSARIUM LPCB

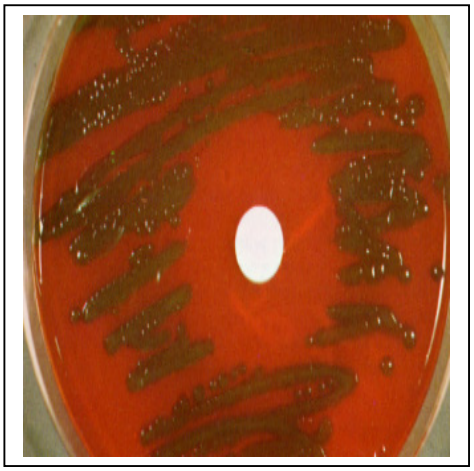


PSEUDOMONAS AERUGINOSA



PSEUDOMONAS CULTURE

PNEUMOCOCCI CULTURE



STAPH GRAM STAIN